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(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXVIII] October—December 1952 [No. 4

IN THIS ISSUE

SUGARCANE CULTIVATION IN SHIMOGA DISTRICT

"POCHA'S SEEDS SATISFY"

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(The responsibility of facts or opinions rests with the several authors of the articles)

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SUGARCANE CULTIVATION IN SHIMOGA DISTRICT

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Introduction

Shimoga District, though classed as a Malnad, is really a composite district, consisting of Malnad, semi-Malnad and Maidan. As one moves from the west to the east, one will find this variation in vegetation, climate and landscape. The rainfall decreases from 300" to 36", and the vegetation from thick ever-green forests to typical Maidan. Hence, it is but natural that the cultivation practices and outlook varies in the different areas, depending mainly on the time-old practices and also to some extent forced by necessity (Fig. 1).

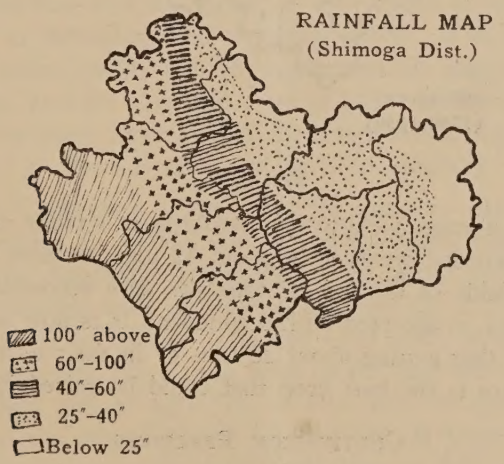


Fig. 1.

Sugarcane cultivation, however, has been very common in this district. The total area has varied from 7,580 to 5,390 acres and has never gone below 5,390 acres. Mostly, it is in the semi-Malnad zone that we find extensive cultivation, it being limited in the Malnad and in the Maidan. Only an extensive area under the perennial Sulekere Tank in Channagiri has made sugarcane cultivation possible in Maidan. Cultural practices vary from place to place (Fig. 2). But the greatest difference is in the manufacture of jaggery. This is mainly due to the variation in the weather. But it is definite that the whole operation from the time of planting to the preparation of jaggery, is done very

indifferently and much is wasted. There is, no doubt, a few very rare striking practices which show the ingenuity of the *ryots*, but they are very rare and on the whole do not help them much. There was a proposal to start a sugar factory in Shimoga which would have helped these *ryots* to concentrate more on its intensive cultivation and increase its yield, but since that proposal was dropped, no progress has been

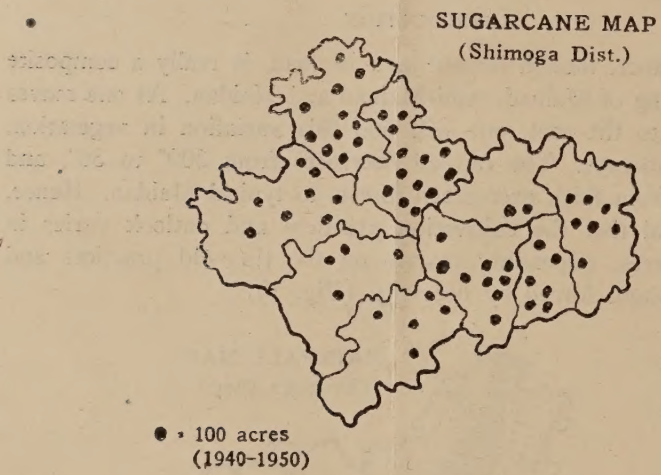


FIG. 2.

achieved. The average yield in the district as it is today is only 20 tons and the best recorded seems to be about 42 tons per acre in Shikaripur Taluk. The yields of 60 and 80 tons per acre recorded by *ryots* in Mandya District, is accepted with scepticism. It is now an almost confirmed opinion that getting about 30 tons or in their terms, 300 md. of jaggery per acre is the best crop that could be raised in this district.

CULTIVATION PRACTICES

I. *Maidan and Semi-Malnad Zones*

(*a*) *Maidan Zone.*—This consists and includes parts of Shimoga, Bhadravati and the entire taluks of Channagiri and Honnali. The average cane area in these taluks is roughly 2,000 acres. There has been a boom in area in 1950-51 and 1951-52 seasons due to very high prices available but that is not normal. In this area the average rainfall is less than 35" and cane is grown under channels and tanks where there is adequate water-supply during summer.

(*b*) *Semi-Malnad Zone.*—In this area, the average rainfall is between 40" to 60". Parts of Shimoga, Sorab, Shikaripur and Bhadravati Taluks, and a very small area in Honnali and Channagiri Taluks

comprise this zone. Mostly, there are bamboo forests and scrub jungles and no thick ever-green forests as in Malnad. This zone consists of the largest area under sugarcane having about 3,500 acres which is almost 50% of the area in the district on the average.

Varieties.—Local "Rasadhali" was the predominant variety in these areas but due to the introduction of H.M. 320, a Departmental improved variety, this has covered a major area of maximum 56% of the total area. In other places this is found mixed with the local varieties. In fact in all places there are only mixtures and no pure variety. Local "pattapatti" is grown in very small areas, and is sold in the market for chewing purposes.

Planting Season.—Sugarcane is planted in this zone, starting from February, just after Shivarathri and extends upto the time of "Bithathane" (*i.e.,* drill sowing paddy), generally upto the middle of *Magi.* Harvesting depends upon the age of the cane and convenience of the farmer and starts from the 11th month and is completed by about the 14th month. Generally this is between the months of March and June. Only rarely do they take this up before Shivarathri as till then the *ryots* will be busy in harvesting and threshing paddy. It is with the money obtained by selling paddy that the appliances for jaggery manufacture are purchased, and the shed and oven is built. Hence the two are not taken up at the same time. Maximum extent will be upto 3 to 5 acres per individual as there is plenty of land and jaggery is marketed.

Primary Cultivation.—The area for cane is earmarked at the time of harvesting the paddy, and it is immediately ploughed up after harvest. Three ploughings are usually done before opening up of the furrows for planting with an interval of about 20 to 30 days between the ploughings. Log harrow is passed after each ploughing in order to break up the clods and also to level up the land where needed. The soil is ploughed and brought into a fine tilth, so that there are no clods left and the entire area is levelled up. If there are any clods left, women coolies are engaged to break them up with wooden mallets. It is only when the entire area is in a fine tilth, furrows are opened up. The total depth ploughed will not be more than 9" in any case.

Furrows.—It is in this that they have invented a very simple apparatus made of wood which when tied to a country plough, gives the effect of a small ridger (Fig. 3). It is a wooden semi-circle, about 9" in diameter and 6" broad. The lower portion rests on the plough point and the upper fits to the beam of the plough. When this is tied up in that position and worked, the earth broken by the plough point is turned over on either side by this plank, leaving a clean, open furrow. Usually the plough is passed twice for each furrow which gives the *ryot* the desired depth and width to the furrows. This gives them the

furrows and at the same time does not strain the animals much. This is one of the few ingenious methods evolved by the *ryots,* at a small cost. The furrows are usually 3′ apart. It is usually determined by the following method. If a man were to extend his hands sideways and drop clods of earth, a furrow should be opened near his feet and at both the clods. This will be roughly 3″ apart.

FURROW PLANK
(Semi-Malnad)

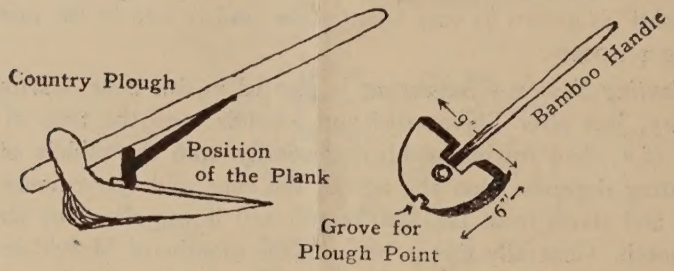


FIG. 3.

Fencing.—Great importance is attached to fencing as it is of utmost necessity in this district. Stray cattle problem is very acute on the one side, and the depradations by the wild beasts on the other. Hence fencing is taken up either just before or just after opening up of the furrows. The bamboo forests nearby help greatly in this as the fence is usually of split bamboos woven into an irregular mat in between the bamboo poles planted at regular intervals. This costs them much and in case only smaller areas of less than an acre is planted, two or three *ryots* select their lands so that they may be adjoining to each other and put up a common fence. This fencing would serve for 2 to 3 years and if necessary, can be removed to adjoining areas for the next crop. They are also sold in the market and are in sections of 4 × 12′ and each such bit is called a "Kathra".

Manuring.—Farmyard manure, which may or may not have been regularly composted, is the only manure applied to cane in Malnad. Fertilisers are very rarely applied and in such cases only ammonium sulphate is applied at the rate of 8 md. per acre. The compost is applied in two ways :—

(*a*) broadcast and ploughed in before opening up the furrows, or

(*b*) applied at the time of planting.

The former is resorted to only in cases where the land is very fertile. This method of application is in less than 10% of the area. In both cases, from 20 to 25 cart-loads of manure is applied

to an acre. The latter method is the general one in this area. In this also 2 types of application are done depending on the method of sowing.

If dry-sown, the setts are put into the furrows and are covered over by manure and the log harrow is passed so that the furrows may be closed.

If irrigated and sown, the manure is applied to the furrows first and then irrigated. The setts are then just trampled or pressed in.

The general practice is the first one, which is carried out by more than 75% of the cultivators. Where the season is late and the area is large, the latter method is resorted to. It is seen that fertilisers, if at all, are generally applied at the time of final earthing up, *i.e.*, when the cane is about 3 months old. Spreading manure is generally done by women.

Seed Rate and Planting.—Cane setts of 11 to 13 months' age are used for seed purposes. They are not of uniform length or size, but they will be of more than 3 nodes. Generally they are of about 1¼' in length consisting of 3 to 4 nodes depending on the cane growth ; 6,000 seed setts of H.M. 320 or 7,500 of other local variety per acre is the usual seed rate. H.M. 320 is the variety that is largely cultivated in this zone. The seed setts are spread in pairs on alternate rows, 3' apart. While planting, the person walking on the ridge takes the setts and puts them in the furrows on either side.

This is an important function in sugarcane cultivation. It is believed that sowing the seed should be very auspicious to give good results. A good day is selected and all the labourers employed on that day are treated well and made happy. They are well fed that day, in addition to the payment of the prevalent wages. Cleaning up the seed setts is done by men, spreading by women, and planting by both men and women.

In cases of dry sowings, the setts are first placed in the furrows and then covered over by manure and then they are closed by passing over a log harrow. In cases of irrigated sowings, the setts are pressed into the earth so that they are not visible and then the harrow passed when the soil gets dry. Passing the log harrow and covering up the furrows is common to both the practices.

Interculture.—Generally four intercultures are done before the final earthing up. This is of two types :

(1) *Ploughing in between the furrows.*—This operation is performed when the seedlings are about 1 month old. In this the country plough is used and it is passed three times between the two furrows, one on either side of the furrows, and once at the middle, so that the sown furrows are filled in by the earth and a new furrow for irrigation is opened up at the centre. This is done when

the lands are in condition after irrigation, manure is covered up well and any weed coming up is automatically removed.

(2) *General Interculture.*—This is done thrice before final earthing up, at an interval of 15 to 30 days. For this, open blade harrow is used. Generally two such are tied to each pair and operated by two men. The harrow being about 1 to 1¼′ wide, one interspace will be intercultivated by each pair at a time. This is to keep the soil in a fine condition to retain moisture as much as possible, as at this stage there will also be a dearth of water for irrigation. This will also help in removing any weed that may have come up, and will lightly earth up the cane rows. One pair of bullocks and 2 men will complete interculture of 1 acre in about 4 hours' time.

Earthing up.—This forms the final intercultural operation till the harvest. No more interculture is done after this. This is usually done when the cane is about 3½ months to 4 months old and is an operation done by men only. About 12 men are required to complete earthing up one acre. In this the earth in the interspace is levelled and the root portion of the cane covered up with it, so that a small ridge is formed along the planted row and a hollow in between which will serve in future as the irrigation channel. If any artificial manures like ammonium sulphate and groundnut oilcake powder are to be applied, they are applied first and the final earthing up taken up.

Drainage.—This is one of the important cultural practices followed by the *ryots* necessitated by the climatic conditions. Most of these areas are rainfed and the rainfall here varies from 40″ to 60″. The precipitation of rain being very heavy in July and August, unless adequate drainage is provided for, the cane is apt to suffer. Hence at the time of planting alone, they make provision for a drain by leaving about 6′ space in the middle of the field, if they are in larger plots, and at the sides if they are in smaller bits. At the time of final earthing up or later if they are planted early, a drain at the place fixed is dug up at right angles to the rows planted. It will be from 1 to 1½′ in width and vary from 1½ to 2½′ in depth based on the condition of the soil and climate. No field will be without this sort of drain, and however heavy the rainfall, all the excess flow being drained off the crop does not suffer.

Weedings.—Weeding depends on the necessity for it. No weeding is done at the initial stages. If it is necessary and there are plenty of weeds, the first weeding will be taken up only at the time of final earthing up. If weeds are in abundance, usually they are removed, artificial manures are applied and the earthing up completed. But in almost all cases one weeding is done in September and October (Deepavali time). Usually due to heavy continued showers and also flow of water from

adjoining fields, weeds grow up abundantly during the monsoon months, and hence the practice of general weeding at the Deepavali time, when the rains will have stopped and only stray showers are expected further. The wrapping up of the cane will have been completed by this time.

Irrigation.—Irrigation is done very judiciously. No flooding is done and it may be due to small availability of water in summer. The first irrigation is at planting either just before or after. Between this and rains, only one or two irrigations are given if the rains are not received. Generally there will be showers in the last week of April or early May and hence, there will be no need for extra irrigation. Irrigation at an interval of 3 to 4 weeks are given after September-October, after weeding has been completed. At this time the rains having stopped, there will be water in all tanks and channels and there will be no difficulty for irrigation and it is continued upto February or till such time as cane is ready for harvest.

Wrapping.—This is essential due to the heavy rainfall when the cane has commenced to form nodes from which roots may grow. Hence wrapping is done invariably, only once, when the crop is 5 or 6 months old. In this operation, the oldest leaves at the bottom are removed and the younger leaves are wrapped around the tillers to make them one compact clump. This will necessarily make them grow erect, and will prevent the tillers from spreading in all directions. Usually this operation takes about 12 men per acre. The final weeding will be easier after this, as it gives good room for the labourers to move about inside the fields.

Harvesting.—Harvesting period varies with the varieties and also on the availability of the milling units. Only well-to-do persons will purchase the units and hire them out to others. Hence, when they are available, *ryots* make use of them. The age of the sugarcane, therefore, varies from 11 months to 16 months in some cases. The usual age is about 12 months. For harvesting, only man labour is employed and in an average stand, about 15 men per acre are required. Harvesting is usually done by long-handled hatchets and rarely with sickles.

This is one of the operations in which the *ryots* have to improve a lot. In many cases the harvesting is done on contract system and so this is done in a very haphazard way. Inspection of cleared and burnt fields show that cane is cut from 6" to 12" above ground level, and misformed canes are many a time neglected and left out. Easily, about 2 tons of cane are wasted per acre which is colossal. In this and subsequent operations *ryots* are so backward that they will have to learn the entire operations afresh.

Manufacture of Jaggery.—This is the worst part of the entire cultivation. In this they are so negligent and careless as to waste a

good deal of money and make sugarcane cultivation a non-profitable work. Generally a big thatched shed (Fig. 4) is put up and sugarcane trash is used to thatch it.

PLAN OF JAGGERY HOUSE

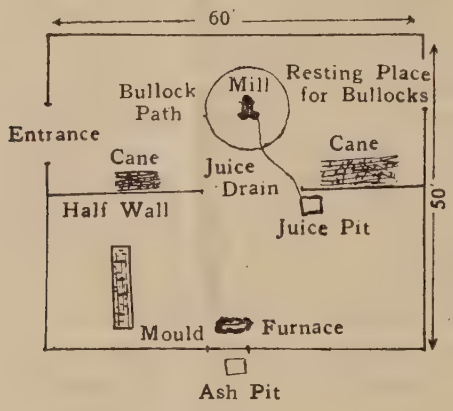


FIG. 4.

The sides are all either bamboo thatches or leafy branches held in place by supporting split bamboos. The shed will be in two sections divided by a half-wall of the same type of mere bamboos. The first section will have sufficient space for the cane mill and movement of the bullocks. The juice from the mill is led into a big pit on the other side of the central wall through a pipe underground. The pit will

PLAN OF FURNACE
(Semi-Malnad)

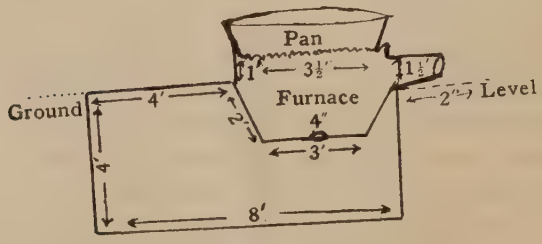


FIG. 5.

have either a big earthen pot or in rare cases cemented chamber for collection of the juice. The juice thus collected will be transported in earthen pots by human agency into the pans. The furnace will be at the centre of the opposite end in the second half and adjoining to

the wall and on one side of it a long wooden trough of about 3" by 12' will be sunk into the earth. This is the jaggery mould.

The furnace is of a primitive type. It is roughly about 4' in diameter and its raised edge is corrugated all round so that when the pan is placed on it, there should be sufficient place all round for the smoke to escape from the sides. A feeder is kept at the middle for feeding the furnace with wooden logs as and when necessary. A wide rectangular pit of about 6' × 4' is dug about 3' to 4' behind the furnace and outside of the wall and this is connected to a slanting tunnel at the narrow lower portion of the furnace. A small hole in the centre of the bottom of the furnace helps the ash to fall through the tunnel into the pit and in order to prevent the ash being blown around, water is put into the pit (Fig. 5).

It takes nearly 15 cart-loads of fuel to manufacture about 300 maunds of jaggery while all the bagasse is simply thrown away outside and strewn all round. They do not even know of its utility. In a very few cases where the jaggery shed is near their home, this is put into the compost pits.

It takes about 3½ hours to get one charge of jaggery. This is not only a slow process but also a costly one, not to mention the waste of fuel. Much of the heat is lost due to innumerable outlets for smoke just beneath the pan ; hence this delay. When the charge is ready, the pan is removed to the nearby wooden mould and it is poured into one of the four sections. Each charge will put forth 4½ maunds of jaggery roughly. Into this, when it is just solidifying, a wooden partition (Fig. 6), is pressed in so that the entire block is divided into 9 equal portions and the jaggery bricks are formed. This is the usual mode of manufacture and the standard shape for making this product.

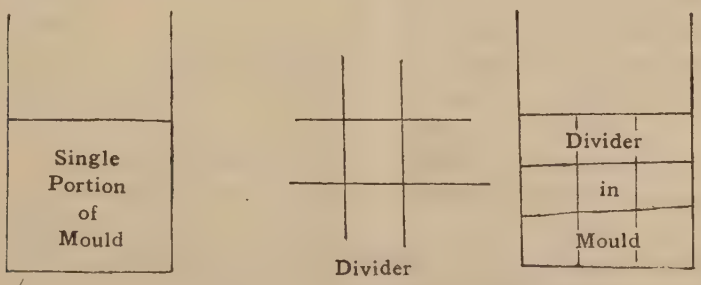


FIG. 6.

Watch and Ward.—In Malnad the problem of the stray cattle is very acute and it is essential that watch be kept. Hence one man at

least is appointed for 6 months in the latter part and he will watch throughout in spite of the fencing.

Cost of Cultivation at Present Rates

	Rs.	A.	P.
1. Fencing Rs. 3 per "Kathra" (12') .. (per year)	45	0	0
2. Ploughing : 1st ploughing 2 pairs 2nd ploughing 3 pairs } (including labour) 3rd ploughing 3 pairs	32	0	0
3. Harrowing and levelling with log harrow after each ploughing (3 pairs)	12	0	0
4. Breaking up of the clods (10 women)	10	0	0
5. Opening up of the furrows (1 pair)	5	0	0
6. Manuring : Cost of 25 cart-loads, transport, and one cart for 4 days	40	0	0
7. Cost of seed setts (6,000 to 7,500)	40	0	0
8. (*a*) Spreading manures (20 women) (*b*) Spreading seeds (4 women) ..	36	0	0
(*c*) Cleaning the seeds (4 men)	6	0	0
9. Log harrow after planting (1 pair)	5	0	0
10. 1st ploughing after planting (3 pairs)	15	0	0
11. General interculture, 3 times (1 pair each) ..	15	0	0
Extra labour (3 men)	4	8	0
12. Earthing up (12 men)	24	0	0
13. Weeding : once before earthing up and once at Deepavali (30 women)	30	0	0
14. Irrigation : 2nd irrigation (4 men)	4	0	0
Final Irrigations after September (4 men) ..	8	0	0
15. Drain digging (8 men)	16	0	0
16. Wrapping (12 men)	24	0	0
17. Harvesting (15 men)	30	0	0
18. Jaggery manufacture :			
(*a*) Cleaning, putting up sheds and building the furnace (12 men)	24	0	0
(*b*) Driving the bullocks, their maintenance and making the furnace and moulding (45 men per acre)	90	0	0
(*c*) Hire charges for bullocks (35 pairs in all) at Re. 1-8-0 per pair	52	8	0
(*d*) Hire charges of crushers and pan (at Rs. 6 per day for 6 days)	36	0	0
(*e*) Lime and kerosene oil	2	0	0

(*f*) Fuel (12 cart-loads at Rs. 6 each) ..	..	72	0 0
19. Watch and Ward (one cooly for 6 months)	..	60	0 0
Total ..	..	838	0 0
20. Cost of the artificial manures, if supplied	..	80	0 0
Grand Total	..	918	0 0

Realisations.—If all the above be done in time, about 30 tons of yield is expected on the average, *i.e.,* 300 maunds of jaggery.

Defects in the System.—Thus it is seen that there is heavy wastage in the process of jaggery manufacture. The good points observed in cultivation and their advantages are completely lost in the slip-shod method of jaggery preparation. The mill-house will be infested with flies and ants as the pans, etc., will not be washed till the complete preparation of one man's product is completed. In addition to this insanitation, there is the smoke problem, which coming out of all sides of the pan, makes it impossible for workers to stay inside. When the charge is poured into the mould, flies will sit in a swarm, get it stuck and die. They are simply scraped off when the moulded jaggery bricks are removed; the ash pit will be a breeding place for malaria as it will be left thus for long periods even upto the next season if they are in any upland.

In addition to the insanitation, there is the wastage of fuel unnecessarily all the while wasting the bagasse which can be used in its place. Wastage of sugarcane while harvesting and the practice of non-application of any artificial manures have gone a long way in reducing the returns to *ryots*. Since more than 50% of all the operations are conducted by the cultivator and his family and no outside manure is generally used, realisation will be adequate. No labour charges of the cultivator is reckoned in the villages in calculation of cost. Due to this we find that sugarcane is cultivated by the owners of the land and not by the tenants generally.

II. Malnad Zone

Malnad Zone.—For purposes of this article, I mean portions of Sagar, Sorab and the entire taluk of Hosanagar and Thirthahalli where generally the rainfall is about 60". In these regions though cane is cultivated it is really with great difficulty. There are no perennial tanks of larger size and under all small *kattes* and minor tanks, areca gardens have been raised. Channels are unknown to this zone. Hence large-scale cultivation as in Maidan are semi-

Malnad is impracticable. Only very small areas are cultivated which will never exceed an acre in extent per individual cultivation. The sugar needs of the cultivator and his immediate neighbour if any, only are considered and general marketing is not thought of. During the summer months it will not be possible to obtain water for irrigation as most of these small *kattes* will be dry. Most of the water here apart from rainfall is carried to the fields by the cultivator and his tenants. Hence these limitations.

Planting Season.—Planting as in semi-Malnad starts in February and continues upto March and April only. It does not extend into May, as by then showers are expected in this zone and paddy cultivation will be taken up and there will be no time to attend to sugarcane. Hence, mostly its planting is completed before the end of March and rarely is it continued in April. Harvesting as usual is taken up in January and is generally completed by March end.

Varieties.—H.M. 320 is the predominant variety grown here. Red Mauritius is also found in some parts and its tillering is very poor. In recent years, some varieties of local cane, as yet unidentified, have been brought from South Canara and are found cultivated mixed with H.M. 320. Introduction of new varieties to try out and get better yields are essential.

Fencing.—This is as in semi-Malnad zone and comprises of the same procedure and expenditure as before. But here the selected field is fenced first before any cultural operation is started. The fencing is cheaper and does not last for more than one year due to the heavy showers.

Preliminary Cultivation and Furrows.—Unlike in semi-Malnad area, there is no ploughing done as in the Malnad zone, practically no *ryot* grows cane for more than half a acre. Only very rich *ryots* with joint families and requiring large quantities of jaggery for consumption put in about one acre and nowhere is there area above this. This is mainly due to the fact that no jaggery is manufactured for the market. Since the area is very limited, the entire cultural operation is done by *human labour*, and at no time are bullocks used except for crushing.

Usually no preliminary cultivation or ploughing is given. In the fields selected, a central drain of about 9″ broad by 12″ deep is opened and furrows 3′ apart is opened at right angles to this drain on either side with the help of the spade. (In cases where one acre of land is brought into cultivation, sometimes pairs are being used and that too, only recently for opening up of the furrows). As such there will be paddy stubbles and any other weeds that might have grown there alone and they are removed if sufficiently grown by human labour or else they will be removed during the course of further operations.

This procedure may be due to the fact that since most of the lands are in small fragments of less than a quarter of an acre and the soil is generally sandy and porous, the cultivation of these small bits is easier and hence the use of human labour.

Manuring.—This is again completely different from semi-Malnad. Here the furrows are all filled in by leaves and straw and burnt up, or else the burnt soil from nearby forest area is brought in and applied. This being generally rich in manurial value, helps the plants very much. Burning leaves in furrows will also have a disinfecting effect.

Then next about 15 cart-loads of compost manure is applied after 1½ to 2 months after planting and light earthing up is done. It is very rare that artificial manures are applied. Only when there is heavy rains and if the cane suffers due to that, a small dose of about 2 to 3 maunds of ammonium sulphate per acre is applied.

Seed Rate and Planting.—There is no uniformity either in the seed rates or in their length. Usually cane bits of 3 to 4 nodes are used and also the tops. But in many cases, one-third cane towards the top is put in as it is without being cut. The planting is also very close. The main feature is that no regular spacing is allowed between the setts. In the furrows the setts are put in in a row with only about 3 to 4" between them, so that interculture is possible only in one way. Hence the seed rate is very high and is more than 10,000 in their own lengthy standards.

Planting is generally taken up in February and completed before the end of March. The seed setts are placed almost end to end in the furrows wherein trash has been burnt or burnt soil has been applied and they are lightly covered over by the adjacent soil. This is done by men with their bare hands or with the help of *munties* (spades) if the soil is hard. If the lands are not in low level or there is severe sun, then these furrows are again covered after planting with leaves just to retain moisture.

Irrigation.—There is no irrigation by channels, etc., and watering is given only carried by men and poured in; water is carried from the nearest available source in earthen pots and poured into the furrows. This is done daily for the first 3 days after planting, and after that on every second and third day depending upon the intensity of the sun. This is continued upto the first showers in late April or early May. After this, as there will be no intermittent rains, there will not be any necessity for further irrigation. The heaviest rainfall being recorded is during July to September, then it will be a problem of proper drainage, it being much more important than in the case of semi-Malnad.

Earthing Up.—About 3 months after planting, the ridges in between the rows which will have been broken up for the light earthing

up are broken up still more with spades and heavy earthing up of the cane rows done, so that furrows will be formed in between the cane rows. All those will be sloping towards the central drain. This operation is also done by men with spades. About 15 men per acre are required.

Drainage.—The necessity for drainage is much more here than in other places. Unless this is adequate, the cane will suffer due to excess water and it results in the failure of the crop. The drains laid down at the time of opening up of the furrows are deepened to 2½ to 3′ and kept clean. This operation goes together with the application of the manures and light earthing up just about in April.

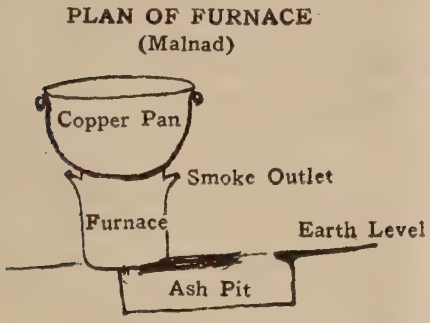
Weeding and Wrapping.—Since the entire plot is dug with spades once at the time of light earthing up and again at the time of final earthing up within the first 3 months no extra weeding is done at that time. All weeds are naturally removed away. One weeding only is done at the time of Deepavali in October or November after rains, and wrapping of the cane is taken up simultaneously. Usually 20 women will be able to complete both these operations.

Harvesting.—Harvesting is taken up very early, generally in the 11th or the 12th month after planting. It is never allowed to go upto the 14th month. Even here, the harvesting practices are very primitive in the sense that there is much wastage. Long-handled hatchets are used for harvest and sickles for clearing the canes. Average yield per acre is very much less than at Shikaripur and is only about 15 tons, and the best crop is about 20 tons.

Manufacture of Jaggery.—Even here it is crude. As the area of cane is very little, no shed, etc., is built. Near to the fields on a higher place, the jaggery furnace is put up in the open. There is very much difference between this and the semi-Malnad types. In this a pit of about 3′ in diameter and 2′ deep is dug and the side-walls are raised to another 2′ so that it will be cylindrical. About 9″ below the top, 2 or 3 small holes with a pipe struck to them are built and this will be for the smoke to pass. Beneath the bottom and towards the opposite side as in the other, a rectangular ash pit is dug up and is connected to it with a small hole at the bottom. Generally these pits are towards the west, so that the blowing breeze helps to fan the flames. There is no corrugation at the top as in semi-Malnad areas, and the smoke outlets being provided for the furnace is filled with fuel. The pan is placed on the top and sealed all round and it is removed only when the charge is ready (Fig. 7).

The pan is generally that of copper and is about 18 to 20″ in height and 4½′ in width and is cup-shaped. Due to the heavy showers and humidity, the iron pans do not serve them for more than 2 years,

and they cannot be repaired as they get rusty. Hence they prefer the copper pans which will serve upto 10 years. The pan is coated with tin on the inside.



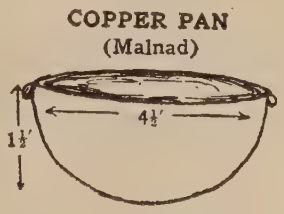


FIG. 7.

This is an improvement on the semi-Malnad system as there is very much cleanliness and also economy. As there is no covering and preservation of milled juice, the insanitation and flies are very much minimised. Cane juice is milled only as and when necessary and even surplus canes are not harvested. Only day-to-day requirements are cut up and brought. The furnace, however, works here also night and day.

The second main feature of this is the saving of fuel to a very large extent. About one cart-load of fuel will suffice for 4 charges at least as all the heat is conserved.

While manufacturing jaggery, the fuel is filled into the pit and lighted. The pan is placed on top and sealed all round with wet mud so that smoke should escape only through the 2 or 3 outlets provided for it at the top. The fire will be fanned by the breeze through the above pit and only when the charge is ready, the pan is removed. About 2 to 2½ hours will be sufficient to get one charge.

Jaggery is preserved only in the semi-solid state. As they do not grow on an extensive scale, they do not think of marketing. Most of it is for local consumption and due to the heavy rains it cannot be preserved well in a solid form. Hence it is always prepared and preserved only in a semi-solid form. When the charge is ready, the pan is removed and the contents are poured into tins or earthen pots and taken home.

Watch and Ward.—Watch and ward is absolutely necessary as in the first case. Here the problems of stray cattle and depredations of wild beasts are far greater due to the thick jungles adjoining than in semi-Malnad areas.

COST OF CULTIVATION AT PRESENT RATES

	Rs.	A.	P.
1. Fencing (Rs. 2 per "Kathra")	10	0	0
2. Opening up of furrows and digging up the drains (40 men)	60	0	0
3. Filling in the furrows with leaves and burning or applying burnt soil (6 cart-loads of leaf or 2 cart-loads of soil)	10	0	0
4. Labour charges for spreading	15	0	0
5. Cost of seed setts at Rs. 30 per 5,000	60	0	0
6. Irrigation (60 coolies)	90	0	0
7. Manuring (cost of 15 cart-loads of manure) ..	75	0	0
8. Covering up and light digging (30 men) ..	45	0	0
9. Deepening the drain (10 men)	20	0	0
10. Heavy earthening up (15 men)	30	0	0
11. Weeding and wrapping (20 women at Re. 1-8-0 each)	30	0	0
12. Harvesting (15 men)	30	0	0
13. Jaggery manufacture :			
(*a*) Putting up the furnace (5 men)	10	0	0
(*b*) Preparing the jaggery, transporting cane, etc., (50 men)	100	0	0
(*c*) Fuel (8 cart-loads at Rs. 4)	32	0	0
(*d*) Hire charges for milling and pan (at Rs. 3 per charge of about 5 md.)	120	0	0
(*e*) Lime, light charges, etc.	13	0	0
Total	750	0	0

Realisations.—200 md. of jaggery.

In summing up the cultivation in Malnad, the following defects are clearly seen :—

(*a*) There is wastage of cane setts and also in harvesting.

(*b*) Though there is slight economy in fuel, its use is there nevertheless.

(*c*) There is no adequate manuring.

(*d*) Cane cultivation is more a hobby in Malnad than an industry.

(*e*) The cane types are also not pure and there is H.M. 320 grown in varying degrees of mixtures with local canes.

The good points of application of leafy manure and burnt earth from the forest and also use of leaves, etc., to retain moisture, are all necessitated due to the seasonal conditions and their availability.

What little manure as such is available will be used for paddy. In addition to all this the wastage of fuel and the insanitary conditions of jaggery manufacture is always there as in semi-Malnad though it is slightly better than in the former.

III. Suggestions and Improvements

Suggestions.—It is seen that sugarcane cultivation in Shimoga District is very backward, though it has some good features here and there which is worthwhile adopting even in other places where cane is cultivated. No portion of the cane cultivation is perfect. Hence much remains to be done and the following are a few items on which improvements were found necessary immediately and work was taken up.

(*a*) Trial of new varieties to find out the best suited new varieties and their further multiplication.

(*b*) Application of artificial manures in regular dosage to improve the yield.

(*c*) Improvements in the manufacture of jaggery.

Improvements

(*a*) 6 new varieties were got from Visvesvaraya Canal Farm and a demonstration plot has been laid out in Thirthahalli Taluk to judge their relative performance. Such trials have also been conducted in Bhadravati Taluk to determine the relative performance of a few varieties for the past few years and the results are being judged.

(*b*) Intensive propaganda about the application of manures have been carried on throughout and in Maidan and semi-Malnad areas, they have taken this up. In Shikaripur Taluk, *ryots* have taken up the application of groundnut cake in the Anjanapur area. Want of sufficient funds at the season, when all operations coincide, has been the main drawback. Application of small doses of ammonium sulphate to cane during the onset of monsoon in Malnad zone is in vogue but this is insufficient. Hence regular manuring has to be introduced and continued.

(*c*) *Jaggery.*—On making a study of these things, I induced a few rich *ryots* to go over to Visvesvaraya Canal Farm at the time of the Visual Education training and showed them the methods of cream jaggery manufacture and also the economy of the modern furnace. They were impressed and forming into a group, they wanted to start a unit. A special fieldman trained in this was deputed and the

furnace was put up and a crusher also. Power was supplied by a tractor and milling and manufacture of jaggery was taken up. This has drawn large crowds of *ryots* from all parts of the taluk and elsewhere and already many are asking our guidance in putting up such new furnaces. A batch of *ryots* were taken by me from Thirthahalli and even there they wanted to put up such a furnace.

The advantages practically demonstrated to them have been as follows :—

1. Due to a power-driven crusher, the percentage of juice obtained was greater and so jaggery obtained also greater.
2. The entire cost of fuel is saved.
3. The furnace is a permanent structure without the need to rebuild every year.
4. It is quite sanitary as only the quantity of juice required as and when required, is milled.
5. The charge is obtained in about 1 to 1¼ hours.
6. When Rs. 3 to Rs. 4 per day hire is being charged for getting 3 to 4 maunds working up at Re. 1 per md. including all their profits, establishments, etc., this party is charging only As. 9 per maund.

A Field Day for the benefit of the Malnad *ryots* and to educate them about this was held and it is gratifying to note their eagerness and enthusiasm and few of the wealthy among the visitors have requested for the erection of such a thing in their villages during the next season.

1. Sri. Hariyappa Gowda, Seeke, Thirthahalli Taluk.
2. Sri. Putte Gowda of Sogilu in Honnali Taluk.
3. Sri. Chandrasekariah of Tyajavalli in Shimoga.
4. Sri. Chidambara Sastry, Bhadravati, were among the many gentlemen who wanted to take up this at once.

It is earnestly hoped that the *ryots* will follow this and make full use of it. The Department, with the co-operation of non-officials, will strive to put up more such furnaces in different parts of the district next season.

SOME LOCAL PRACTICES PREVALENT IN THE MYSORE STATE IN THE CONTROL OF INSECT PESTS
(Somewhat Anecdotal)

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Introduction

Insects existed on earth long before the advent of man. From the time he settled down to civilised life and began to raise crops, the problem of protecting them from insect pests has been his great and constant concern. Naturally various ideas were entertained and often numerous methods of control were utilised in different countries. In India, Ramakrishna Ayyar[3] has given a very interesting account of the practices in vogue in the Madras State. The beliefs and agencies of control prevalent in the Mysore State are almost similar and equally interesting.

Beliefs Regarding Origin and Nature of Insect Pests

India is steeped in religion, tradition, sentiment, customs and observances. The Mysore *raiyat* is no exception to this general rule. He believes that an insect outbreak is primarily an act of God ; it is due to God's curse, sins of man, evil spirit, evil eye, a bad wind, failure of rains, etc. Some of these beliefs will not appeal to scientific men, for example, the crude and often meaningless talisman to ward off the evil spirit or the effects of evil, which is a common sight in any fruit orchard (Fig. 2) ; whereas others are real causes and are based on years of experience, though a scientific explanation may not at once be available for some of these ; common examples are : the good influence of *Vishaki* rain against insect pests, the association of east wind (*Mudallu*) with the occurrence of the pests, or the stress laid on the time of sowing particular crops to avoid pests.

Religious or Faith Cures

In many rural parts the *raiyats* honestly believe in the supernatural causes of insect outbreaks and adopt an attitude of resignation allowing the pest to take its natural course. Many others offer prayers (Fig. 1) ; in fact, any agricultural operation is commenced and ended with a prayer, and the harvest festivals—*Pongal* or *Puja*—are in the nature of thanksgiving services. In extreme cases, charms, *mantras,*

talismans, etc., are used. Prayers are offered to the local deity *Junjappa,* promising some castor oil for the temple use, in the case of an outbreak of the castor semilooper in certain parts of Tumkur and Chitaldrug Districts. In Channagiri Taluk (Shimoga District) *Mantrawadis*—professional religious men—chant *mantras*—sacred hymns—to drive away the jola grasshopper pest, holy water is sprinkled in the infested fields and talismans are used. In Koppa Taluk (Chikmagalur District), against the paddy *Leptispa,* pig is offered as sacrifice to the village deity and the blood is sprinkled in the infested fields, accompanied by a ceremonial dance and chanting of songs by labourers. Though these beliefs are so queer, many *raiyats* have implicit faith in them even to this day. The reason for this is not far to seek. Usually these observances are performed at the stage of climax of the pest or at the tail end of its life- or seasonal-history, which is generally followed by an immediate decline or the period of inactivity, with the result the insects disappear from sight ; of course, the credit goes to the Supernatural !

In Tumkur and Shimoga Districts, against the castor semilooper, the local deity *Mari* is offered food by cooking rice under the trees and scattering it in the infested fields. The crows are attracted to the cooked rice, and they feed on the loopers also, which are thus destroyed. *Mari* has answered the prayers favourably !!

Other Methods

Cultural.—Inter-ploughing (*Magi-ukke*) is regarded by the *raiyats* as a very important operation. From the entomological point of view it is highly significant, because underground stages of crop pests are thereby destroyed or exposed to enemies such as birds ; this is indeed a great advantage.

Periodical weeding, flooding, draining of water, growing of mixed crops, rotation of crops, seasonal ploughing, etc., are some routine, but at the same time very useful, practices devised by the intelligent *raiyats* with the local experience of several generations.

Mechanical.—Similarly netting, bagging, smoking, ant-pans, etc., are in every-day use.

The covering of the ripening pomegranate fruits with cloth bags against the pomegranate butterfly has the approval of the entomologist.

Ramakrishna Ayyar[3] points out that the common practice of tying a big brush-like tuft of black wool round the neck of the cart bullocks in the hill tracts (*Malnad*) keeps away to a considerable extent the biting flies, which are a great source of annoyance to them.

Insecticidal.—Wood ash, sometimes sprinkled with kerosene oil, is commonly used against aphids on cabbage, brinjal, beans, etc., in the vegetable gardens.

Fig. 1. Offering prayer to Goddes 'Mari'

Fig. 2. A scarecrow commonly used to ward off effects of evil eye.

Persons who climb trees for harvesting mangoes, smear their hands and legs with wood ash against the troublesome red ants. This is of uncertain utility.

Against the Rhinoceros beetle on coconut palm, (*i*) *Kol kalli* (an *Euphorbia*) twig is planted by the side of each coconut seedling ; (*ii*) common salt and asafœtida are tied in a piece of cloth and placed on the crown of the plant ; and (*iii*) castor oil gust is exposed in shallow pans to attract beetles ; similarly rice-water, fermented toddy, etc., are used. (*i*) and (*ii*) are not effective, although salt applied into the cavities made by the beetles may prevent fungal growth ; practical value of (*iii*) is doubtful.

For the control of the paddy *Leptispa* the *raiyats* in Sringeri Taluk (Chikmagalur District) applied bamboo (tender), *Tephrosia nicotianifolia* and other insecticidal plants to the infested fields ; but the results were negative.

Methods Against Store and Household Pests

Sun-drying of harvested grains, pulses, chillies, etc., is mechanically done by all the *raiyats*. It has been scientifically proved[2] that drying to a "safe" water content, *viz.*, below 10 to 11%, is the most effective method to render grain safe for storage against insect pests.

In many rural parts jola is preserved in bins together with neem (*Melia*) leaves ; the effectiveness of this treatment is not substantiated.

Use of small quantities of mercury in store grains is a very old practice in Mysore. Mercury is also used in minute quantities in a wax cell for preservation of pickles, etc. This treatment has been found very effective and the action of mercury has been proved scientifically.[1]

Application of turmeric, kumkum, etc., to the doorsteps is a very common practice in the houses. Neem leaves are hung on doors, particularly on festivals. Perhaps this prevents the entry into houses of crawling insects in the former case, and of the flying insects like the mosquitoes in the latter case.

Barriers of sand are put near the walls to control the bed-bugs. The fully-fed bugs cannot climb up and cross the barrier and thus their escape during the night is prevented.

Dried chillies and their powder, camphor, etc., are used against clothe moths, silverfish, etc., in boxes. These are now largely replaced by naphthaline.

Conclusion

In spite of the fact that many of the practices noted above are empirical and devised on an imperfect knowledge of the insects and

their life-history and habits, some of them have real practical value and must be regarded as the beginnings of our present-day scientific methods.

ACKNOWLEDGMENT

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References

1. Krishnamurti, B., and Appanna, M. *The Current Science,* Vol. 14, pp. 7-10, and Vol. 14 (Jan. and July, 1945), pp. 168-70.
2. Ramakrishna Ayyar, T. V. *The Agricultural Journal of India,* Vol. XVI, Pt. I (1921), pp. 40-51.
3. Oxley, T. A. *The Scientific Principles of Grain Storage.* The Northern Publishing Co. Ltd., Liverpool, 1948, p. 34.

MANURES AND FERTILIZERS: THEIR EFFICIENT AND EFFECTIVE USE FOR INCREASED CROP PRODUCTION

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AND

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General Hints

Manures and fertilizers supply the materials needed by the plant for its satisfactory growth and as such their addition enriches the soil with these essential plant food materials. The term manure is by convention used to refer to materials containing organic matter which usually are derived from natural sources, while the term fertilizer is restricted to materials of a purely mineral origin and usually manufactured artificially. These materials supply the major plant food elements, nitrogen, phosphorus and potash in varying quantities singly or in combinations depending on their nature, and besides these may supply other elements also.

Nitrogen is the element influential in causing luxuriant growth of plant material, resulting in the formation of more leafy matter and straw. Nitrogen is a constituent of proteins and as such essential for seed formation of cereals and legumes. Our soils usually lack in this element and as such it is necessary to ensure its supply in sufficient amounts to practically every type of crop. Nitrogen is supplied through organic manures like farmyard manure, composts and oilcakes, and through concentrated mineral fertilizers like ammonium sulphate, ammonium nitrate and chilean nitrate (sodium nitrate). The compounds of nitrogen are usually easily soluble in water and even if in organic forms are easily mineralised and rendered soluble. As such, when these materials are applied on to the surface of the soil, they pass through the soil layers and reach the plant roots easily. This easy solubility while being an advantage from point of ready availability to the plant is a serious disadvantage because of the liability to rapid loss through leaching and loss by drainage under conditions of heavy rainfall or excessive irrigation.

Phosphate helps increased root development and produces more grains. It also gives plants the resistance required to withstand attacks by diseases and pests. Our soils in general are poor in phosphate content and the soils in the Malnad region are particularly so. The availability of soil phosphates to crops is further influenced by the reaction of the soil—in acid soils the phosphate being much less available than in soils having a neutral or a slightly alkaline reaction. Phos-

phate has the effect of counteracting the effects of excess of nitrogen and balanced combinations of phosphates and nitrogenous materials are found to be best suited to our soils for obtaining maximum crop yields. Compared to nitrogen compounds, phosphates are less easily dissolved and in consequence phosphatic fertilizers suffer from certain disadvantages which tend to restrict their usefulness to plants. The soluble phosphates of phosphatic fertilizers which go into solution after their application, tend to react quickly with soil minerals and get converted into insoluble or "fixed" forms of phosphate salts. This "fixation" naturally limits their movement from the localised region of application, and being insoluble, the "fixed" phosphates are not available for absorption by the roots even if present in proximity to the roots. This fixation of phosphatic fertilizers takes place rapidly in acid soils, *i.e.*, those soils which show a reaction on the acid side, while in neutral soils this change, though not so rapid, takes place sufficiently fast as to restrict its usefulness even to the growing crops unless suitable measures are taken. In the case of acid soils, these disadvantages can be minimised by prior neutralization of the soils through application of required quantities of lime. In neutral soils, the effects of fixation can be reduced and the usefulness of the fertilizers increased through judicious application in soil layers close to the root zone and also by growing crops which have a strong capacity to feed on the phosphates. Application of fertilizers close to the root zone is achieved by the development of the method known as "placement", which involves application of the fertilizers at suitable depths below the soil surface, and in narrow continuous or else broken bands so that contact with soil particles is minimised and a high concentration of the fertilizer obtained in the zone of root growth.

Potash is the element which helps development of starch in cereal crops and which gives well-filled grains. The potash supplies in our red soils is found to be usually high, and rarely are any beneficial results on crops obtained through potash manuring. Potash application is however found to be necessary for crops like potato and tobacco which make a special demand for this element and in the case of such crops, potash fertilizers are best given in balanced proportions with nitrogen and phosphates. For the general field crops, including sugarcane, however, potash application have been found to be unnecessary.

I. The Problems of Manuring Paddy—the Optimum Time of Application of Nitrogen

Following an extensive series of manurial trials it has been found that almost invariably the paddy crop gives an increase in yield with the application of nitrogen in some form or other. However, this in-

crease has varied from 10% to almost cent. per cent. This variation is due to differences in the nature and initial fertility of the soil, but the more important is due to the dose, the method and time of application. Efficient fertilizer use can result only when the nutrient element is used to its fullest extent by the plant. Therefore, a careful consideration has to be given to the choice of fertilizer, the dose, and the time and method of its application. While we do not have all the facts, it may be stated that nitrogen in the form of nitrate applied to the crop in the seedling stage is not fully or effectively utilized and that the organic or ammoniacal is the better form in which this element is utilised in the earlier stages of growth of the crop. As such the application of oilcakes or ammonium sulphate at the time of transplantation are better than application of sodium nitrate or other nitrate-containing fertilizers. Response of rice yields to nitrogen is closely related to the initial fertility of the soil, but on soils of moderate fertility the crops respond well to the application of 20 to 40 lb. of nitrogen, a dosage of 30 lb. N being considered a satisfactory dosage.

The customary method of applying ammonium sulphate consists in broadcasting the fertilizer on the puddled soil after planting. It is now known that nitrogenous fertilizers whether in the ammoniacal or nitrate forms applied to puddled or water-logged soils on the surface are largely lost to crops on account of a variety of chemical and biological changes taking place in them. Hence, the above-mentioned practice is likely to result in considerable loss of nitrogen, with the result that full use is not made by the growing plant of this element. Coupled with the fact that the young seedlings are not in a position to utilize all the nitrogen made available to them, a large part of this element supplied in the early stages is not utilized and thus there is wastage of the fertilizers added to the soil. Delayed application of these fertilizers till after the plant has established itself and after conditions in the soil have become more favourable for such application can thus be expected to give better benefit to the crops. With this in view and with the object of ascertaining the optimum time of application of ammonium sulphate for paddy, experiments were started on small-scale in the pot culture house and were later continued on plots at the Experimental Farms at Mandya, Nagenahally, Babbur and Hebbal. The results obtained are summarised in Table I.

The observations carried out on the crop in the above experiments indicated that application of ammonium sulphate at the end of 4 weeks after planting resulted in almost all the tillers formed giving out earheads, whereas earlier applications of nitrogen increased leaf-growth without correspondingly increasing grain formation. Further, the average weight of grain per earhead was higher in the case of the

crops supplied with nitrogen at the end of the second fortnight compared with that which received the fertilizer at the time of planting, indicating satisfactory grain formation in the former case. The yield data in general indicate that the best increases in yield are obtained when ammonium sulphate is applied at the end of 4 weeks after planting.

Field experiments were conducted at the different experimental farms over a period of years and the results obtained are set out in Tables II to VI.

TABLE I

Experiments to ascertain the optimum time of application of nitrogen to paddy (Pot culture house experiments)

Yield Data

Treatment	1946–47 Grain	1946–47 Straw	1947–48 Grain	1947–48 Straw	1949–50 Grain	1949–50 Straw	1950–51 Grain	1950–51 Straw
1. 80 lb. of Am_2SO_4 applied at the time of transplantation of paddy	2880	3286	3193	3795	2423	3639	1375	3270
2. Do at the end of 1st fortnight	2848	3510	3474	3859	2442	3820	1457	3260
3. Do at the end of 2nd fortnight	3414	3723	3702	4406	2884	4440	1447	3130
4. Do at the end of 3rd fortnight	3197	3659	3485	4231	2693	4435	1412	3330
5. Do at the end of 4th fortnight	3062	3483	3656	4088	3006	3990	1363	2870

N.B.—The figures in the columns are yields of grain and straw in grams from an area of 5 sq. yards and total of five replications.

TABLE II

Experiments on the optimum time of application of ammonium sulphate to paddy

V. C. Farm, Mandya

Treatment	1947–48 Grain	1947–48 Straw	1948–49 Grain	1948–49 Straw	Average of 2 years Grain	Average of 2 years Straw
1. 80 lb. af Am_2SO_4 applied at transplanting	2782	3214	1280	2016	2031	2615
2. Do at the end of 1st fortnight	2355	2912	1344	1600	1849	2256
3. Do at the end of 2nd fortnight	2988	3671	1376	1712	2181	2692
4. Do at the end of 3rd fortnight	3002	3484	1488	2176	2245	2830
5. Do at the end of 4th fortnight	3098	3238	1216	1696	2157	2467

A basal dressing of 3,000 lb. of green mannure 3 weeks before and 56 lb. bone meal at planting per acre were applied.

TABLE III

Paddy Breeding Station, Nagenahally

Treatment	1947-48 Grain	1947-48 Straw	1948-49 Grain	1948-49 Straw	1949-50 Grain	1949-50 Straw	Average of 3 years Grain	Average of 3 years Straw
1. 80 lb. of Am_2SO_4 at planting	2040	2407	1840	3340	2107	4080	1996	3276
2. Do at the end of 1st Fortnight	2246	2803	1893	3447	2320	3893	2153	3381
3. Do at the end of 2nd fortnight	2226	2740	1833	3120	2347	4380	2135	3413
4. Do at the end of 3rd fortnight	2160	2573	1713	3253	2173	3920	2015	3249
5. Do at the end of 4th fortnight	2133	2460	1727	3040	2187	3953	2016	3151

A basal dressing of 3 000 lb. *Hongey* leaves 3 weeks before and 56 lb. bonemeal at planting per acre were applied.

TABLE IV

Babbur Farm

Treatment	1947-48 Grain	1947-48 Straw	1948-49 Grain	1948-49 Straw	1949-50 Grain	1949-50 Straw	Average of 3 years Grain	Average of 3 years Straw
1. 80 lb. of Am_2SO_4 at planting	832	1416	1952	4288	1408	2496	1397	2733
2. Do at the end of 1st fortnight	704	1408	1648	3976	1464	2808	1272	2283
3. Do at the end of 2nd fortnight	968	1536	2040	4080	1808	2888	1605	2835
4. Do at the end of 3rd fortnight	736	1288	1384	3600	1824	2960	1315	2616
5. Do at the end of 4th fortnight	880	1384	1736	4184	1584	1784	1067	2451

Basal dressings:—47-48: 3,000 lb. green leaves 3 weeks before planting and 56 lb super at planting per acre; 48-49; 5,000 lb. of *Hongey* leaves and groundnut tops 3 weeks before and 56 lb. super at planting per acre; 49-50, *Dhaincha* grown after application of 56 lb. super was ploughed in 3 weeks before planting,

TABLE V

Paddy Breeding Station, Nagenahally, 1950-51

Treatment	Grains	Straw
1. 100 lb. of Am_2SO_4 applied at planting ..	1143	2675
2. Do at the end of 6 weeks ..	1277	2831
3. 50 lb. at the end of 4 weeks + 50 lb. at the end of 6 weeks ..	1388	3119

Basal treatment: 1 ton of compost and 56 lb. super at planting.

INFLUENCE OF TIME OF APPLICATION OF AMMONIUM SULPHATE TO PADDY

(Experiments in the Pot Culture House)

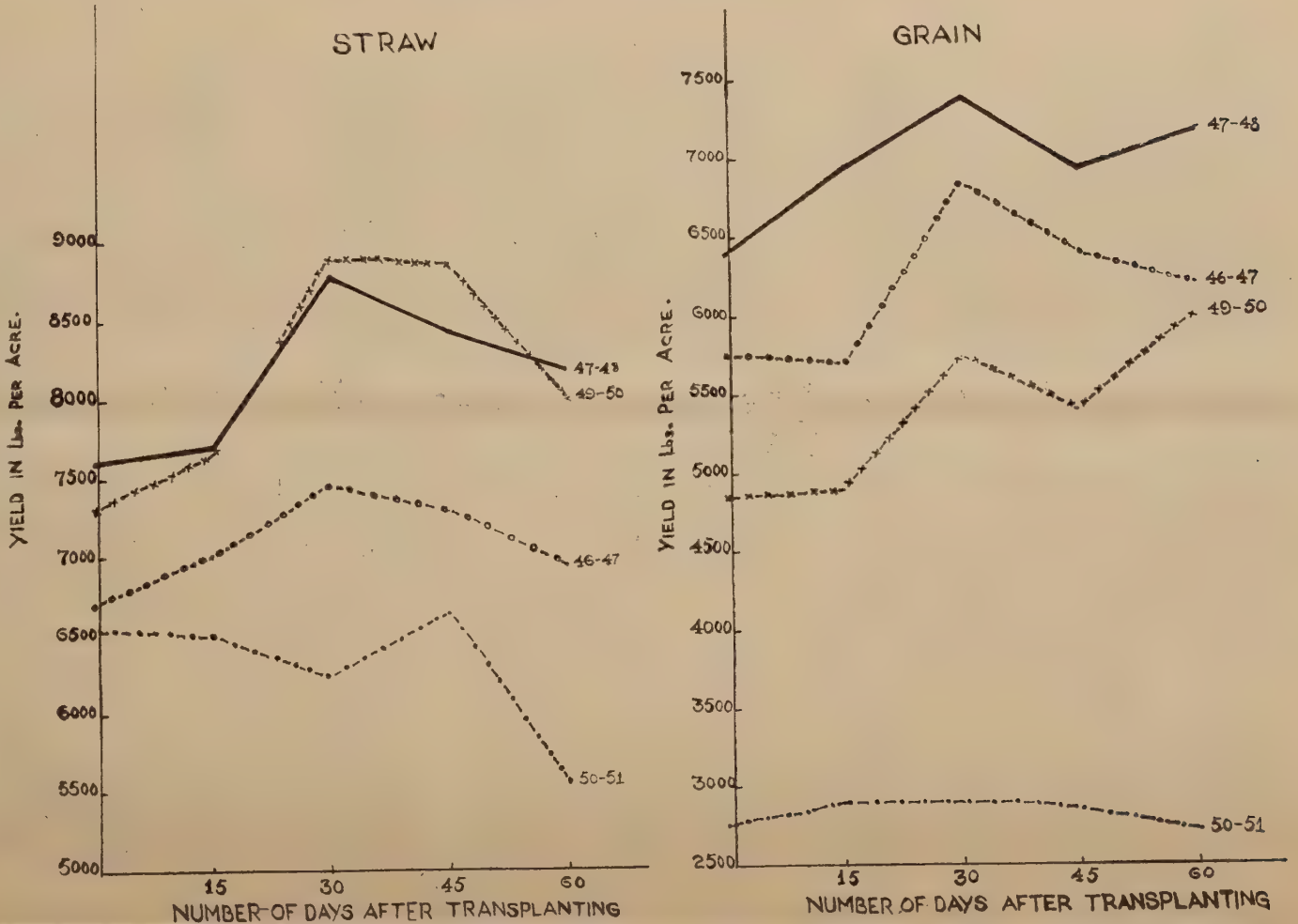


TABLE VI

Hebbal Farm, 1951-52

Treatment	Grains	Straw
1. 6⅔ maunds of groundnut cake + 2 maunds of Am_2SO_4 at planting ..	2540	7120
2. 6⅔ maunds of groundnut cake at planting + 2 maunds of Am_2SO_4 at the end of 4 weeks ..	2861	7447

Basal dose: 1 ton farm compost and 56 lb. super at planting.

N.B.—The figures are yields of grain and straw in lb. per acre.

The yield data given in Tables II to IV are graphically represented in Figs. 1 and 2.

The results of the various experiments thus indicate that the application of ammonium sulphate to paddy after an interval of 4 to 6 weeks from the time of transplantation gives higher crop yields than the usual method of applying this entire dose of fertilizer at the time of planting. On the basis of the above findings and other field experiments, the following manurial treatments are recommended. The usual basal dressing of 3 to 4 cart-loads of farmyard manure or compost and 3 to 4 cart-loads of green manure per acre should be given in all cases. Artificials to supply 15 lb. nitrogen and 12-15 lb. of phosphoric acid should be given at the time of planting, and another 15 lb. of nitrogen given 4-6 weeks after planting making a total of 30 lb. of nitrogen. The mixtures supplying the above nutrients will be as follows :

Mixture I for application at planting : 80 lb. groundnut oilcake + 40 lb. ammonium sulphate + 56 or 84 lb. of superphosphate.

Mixture II : applied at the time of first weeding or two weeks thereafter : 75 lb. of ammonium sulphate or a mixture of 65 lb. ammonium sulphate + 35 lb. groundnut oilcake.

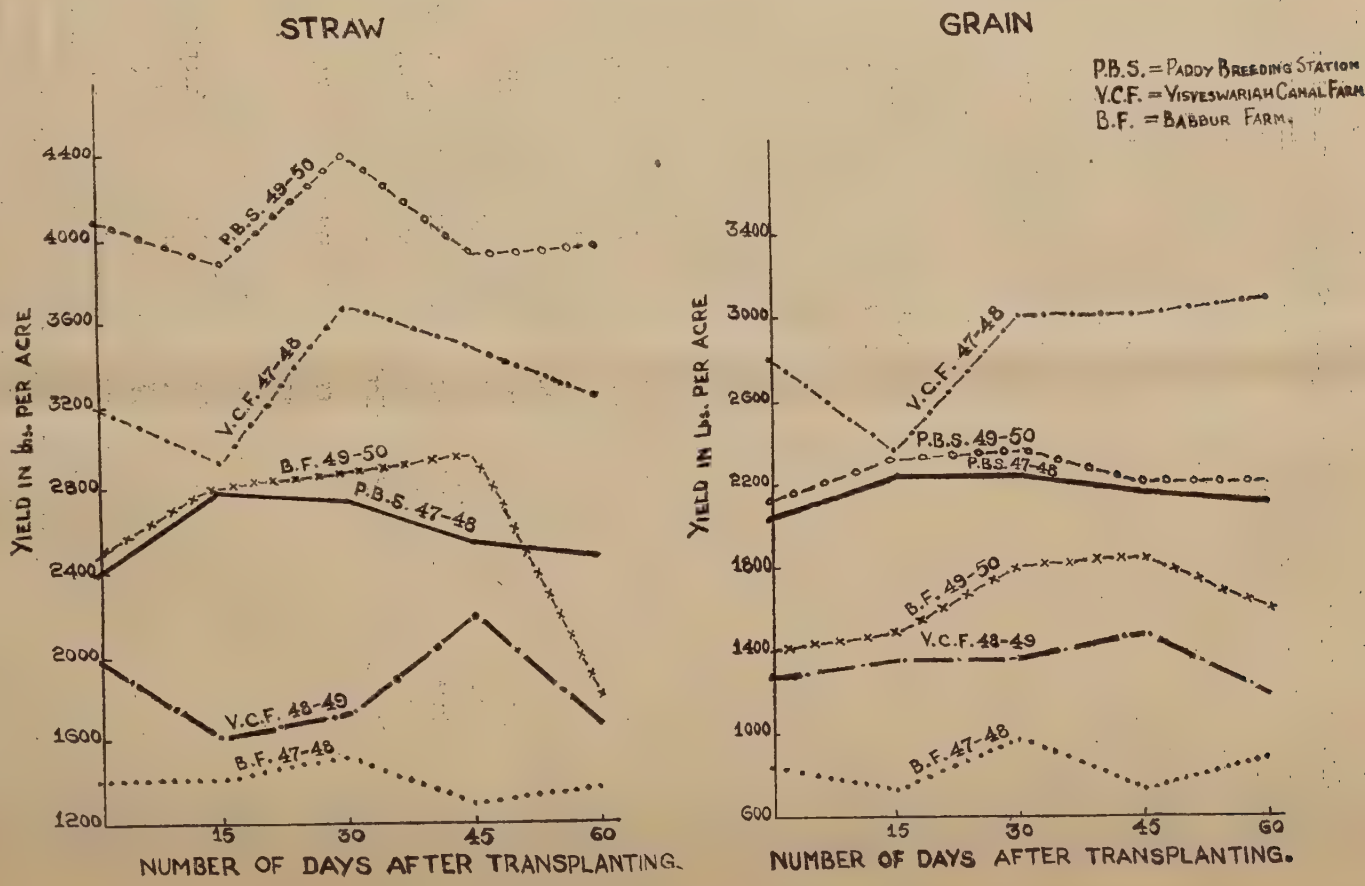
II. INCREASING THE EFFECTIVENESS OF PHOSPHATIC FERTILIZERS TO CEREALS

(*a*) *Fertilizing Green Manures with Phosphatic Fertilizers*

In field experiments to study the response of crops to phosphatic fertilizers, it is our experience that anomalous results are frequently obtained, in that positive benefit is obtained on occasions and at other times no such benefit is noticed. This is generally so in the case of paddy, where phosphatic fertilizers have often been found to give little or no increase in crop yield. In the case of ragi, however, the improvements in yields with phosphate applications are observed to be more consistent. This variability in the effectiveness of phosphate to these

INFLUENCE OF TIME OF APPLICATION OF AMMONIUM SULPHATE TO PADDY

(Field Experiments)



Figs. 1 and 2 illustrating Tables II to IV.

crops is attributed to the fixation they undergo in the soil whereby they are converted in varying degrees into forms unavailable to the crops, depending upon the soil types, conditions of cultivation, manuring, etc. The cereal crops being equipped with only shallow root systems are incapable of utilising these forms effectively. The case is, however, different with leguminous crops which are equipped with deep and extensive root systems and in addition, being strong feeders on phosphates, appear capable of absorbing to a much larger extent the added phosphates than do the cereals. Phosphates stimulate the growth and activity of micro-organisms, particularly the nitrogen-fixing organisms associated with the root nodules of legumes and the increased activity of these organisms results in much larger quantities of nutrients including nitrogen and phosphates being made available,

TABLE VII

Pot experiments in 1945-46 *to study the influence of application of bonemeal to sunnhemp on its yields and on the yield of the following crop of ragi*

Treatment	Sunnhemp in grams	% N	% P_2O_5	Ragi grain in g.	Ragi straw in g.
1. Sunnhemp grown with bonemeal applied at 1 cwt. per acre	1065	0·58	0·082	95	132
2. Sunnhemp without bonemeal	979	0·49	0·063	72	124

Each treatment was replicated in pots and the yields are a total of 4 pots.

TABLE VIII

Summary of field experiments in 1945-46 *on the application of bonemeal to sunnhemp and horsegram preceding a crop of paddy (Jowar grown at Babbur Farm instead of paddy)*

Treatment	Irwin Canal Farm			Nagenahally Farm			Babbur Farm	
	Green matter in lb. per acre	Paddy grain in lb. per acre	Paddy straw in lb. per acre	Green matter in lb. per acre	Paddy grain in lb. per acre	Straw in lb. per acre	Green matter in lb. per acre	Jowar stalks in lb. per acre
1. Sunnhemp with bonemeal at 1 cwt. per acre	9439	1460	2100	3117	2317	4042	10,400	1026
2. do. without bonemeal	3564	1227	1935	2205	2468	4076	6,400	862
3. Horsegram with bonemeal at 1 cwt. per acre	5360	1432	2426	4557	2409	4414	7,100	972
4. Horsegram without bone meal	2473	1104	2056	3125	2211	4178	4,900	826

and thus absorbed by the plants. Phosphate applications to leguminous crops are found to result in a larger quantity of green matter being produced and, besides their content of nitrogen, phosphorus and other minerals are also found to be larger. These findings, in conformity with the observations of various workers, both in India and abroad, are borne out by the experiments conducted by us on both small-scale pot and large-scale field experiments. Tables VII and VIII set out the results obtained by us over a number of years.

The above observations are utilised for increasing the effectiveness of phosphates to cereal crops like paddy, where otherwise only poor response is obtained, by raising a luxuriant leguminous crop through fertilization with phosphates and using this crop as a green manure for the paddy crop following it. The above indicated results show that applications of superphosphate or bonemeal at ½ to 1 cwt. to the acre increase the green matter yield of groundnuts, sunnhemp and *dhaincha* (yield figures not given here) by 20 to 50% and that the use of these as green manure to paddy without further applications of phosphatic fertilizers give superior crop yields than treatments involving applications of same dose of phosphates directly to the paddy crop. The improved practices yield easily a 10-20% larger crop of paddy and hence are advantageous. Similar improvements in yields of ragi following a green manure which had been fertilized with phosphates are obtained in field experiments, but the method appears to suffer from disadvantages owing to the difficulty felt by *ryots* for raising a leguminous crop under rainfed conditions during the summer and using the same as a green manure for the succeeding rainfed monsoon ragi crop. Where this practice can be adopted, this can be unhesitatingly recommended as being advantageous and also as a means of sparing the use of farm manure, or augmenting its supply, for the dry crop.

TABLE IX

Effect of increasing doses of P_2O_5 on the yield and composition of cowpea and on the ragi succeeding it, in pots (1947-48)

Treatment	Cowpea seeds in g.	Cowpea plant material in g.	Ragi grain in g.	Straw in g.
1. Cowpea wtth no phosphate	17·4	24·7	22·9	16·0
2. Cowpea with 12½ lb. of P_2O_5	18·9	24·8	30·2	62·9
3. Cowpea with 25 lb. of P_2O_5	24·1	22·7	35·1	71·3
4. Cowpea with 30 lb. of P_2O_5	23·0	31·8	35·7	84·1

P_2O_5 was applied as superphosphate. Yields are from 4 pots, each treatment having been replicated 4 times.

The fertilization of leguminous crops with phosphates is also advantageous where the crop is grown to maturity to produce pulse and leguminous seeds. Larger yields of the seed as well as of the plant material are obtained and besides, their content of nitrogen and phosphoric acid are also larger.

TABLE X

Composition of cowpea crop in above table on oven-dry basis

Treatment	Cowpea seed			Cowpea plant material			N & P_2O_5 in the crop from unit area (1 sq. yd.)	
	Ash %	P_2O_5 %	N %	Ash %	P_2O_5 %	N %	P_0O_5 g.	N in g.
1. Cowpea no phosphates ..	6·82	1·20	4·16	14·06	0·33	2·18	1·16	5·05
2. Cowpea 12½ lb. P_2O_5 ..	7·10	1·73	4·30	12·70	0·41	2·28	1·71	5·51
3. Cowpea 25 lb. P_2O_5 ..	7·72	1·91	4·33	11·82	0·45	2·35	2·25	6·32
4. Cowpea 50 lb. P_2O_5 ..	7·68	1·89	4·31	10·78	0·51	2·38	2·30	7·09

Above tables show that P_2O_5 at 25 lb. level, corresponding to just over 1 cwt. per acre of superphosphate, has given an increase of about 50% both of cowpea and the ragi succeeding it over the untreated crops. These findings are of value not only as a means of producing more crop, but for producing crop of better nutritional value. The quantities of protein and the valuable phosphates contained in the phosphate manured crop are greater than in the crop not so manured and as such this method of manuring is doubly beneficial.

TABLE XI

Application of bonemeal to horsegram and its effect on the yield and composition of the same and on the succeeding crop of ragi

In plots 1947-48

Treatment	Horsegram seed in g.	Horsegram plant material in g.	Ragi grain in g.	Ragi straw in g.
1. Horsegram without bonemeal	6041	5435	371	802
2. Horsegram with bonemeal at ½ cwt. per acre	6637	5980	423	893

Yields are from an area of 15 sq. yds. and total of 5 replications.

TABLE XII

Composition of horsegram in table above on oven-dry basis

Treatment	Horsegram seed			Horsegram plant material			Amount of N and P_2O_5 contained in the crop from 1 sq.yd.	
	Ash%	P_2O_5%	N%	Ash%	P_2O_5%	N%	P_2O_5 in g.	N in g.
1. Horsegram without bonemeal	3·40	0·42	3·82	11·81	0·22	1·83	2·49	22·01
2. Horsegram with bonemeal	3·08	0·47	4·05	10·01	0·35	2·00	3·48	25·90

(b) Placement of Phosphatic Fertilizers at Depths below Soil Surface

The relative immobility of phosphates, unlike the easy mobility of nitrogenous fertilizers, makes them unsuitable for broadcast application except for the very shallow rooted crops. The ease with which they react with soil minerals and revert to insoluble forms, further makes it necessary to ensure that they are applied to soil in regions where the plant roots can effectively extract them. This becomes particularly necessary with crops like potatoes and similar tubers which are poor feeders upon phosphates and which cannot fully utilise phosphates unless supplied in readily soluble and available forms in sufficiently high concentration. These handicaps can be overcome by "placing" the phosphatic fertilizers below soil surface, approximately at depths where the plant roots are concentrated, by drilling either with or before the seeds are sown, or in the case of planted crops, placing either before transplantation or after the crop has established itself. The fertilizer applied by this method will be in narrow concentrated bands in rows where the plant roots are concentrated contrary to the diffuse distribution of broadcast applications, and contact with the soil particles will be comparatively minimised and thereby the soluble phosphate retained in an available form in a concentrated region and for a much longer period. The "placement" method gives increased crop yields and in many cases an economy in the fertilizer used can be effected since only a part of the fertilizer placed at proper depth can give as much yield as the full dose applied broadcast at the surface.

The results of pot-house and field experiments conducted on ragi, by placing the superphosphate at different depths are set out in the following tables.

TABLE XIII

Experiments on the placement of superphosphate at depths in the plots in the pot-culture house

Treatment	Ragi grain	Ragi straw	Ragi grain	Ragi straw
	1947-48		1948-49	
1 Control—no phosphate	493	856	334	597
2 Superphosphate at ½ cwt. per acre applied at surface	579	927	344	657
3 Do at 3" depth	613	1036	416	744
4 Do at 6" depth	666	1056	400	734
5 Do at 8" depth	551	976	397	673

The figures in the columns are yields in gm. from an area of 7 sq. yds.

TABLE XIV

Experiment on the placement of phosphate at depths and its influence on the yield of ragi and recovery of phosphoric acid in the crop In pots in the pot-culture house 1949-50

Treatment	Ragi yields in g.		Amount of plant food in the crop in g.	
	Grain	Straw	P_2O_5	N
1. Control—no phosphate	108	157	3·09	8·21
2. Superphosphate applied at surface	123	216	5·29	10·88
3. Do at 3" depth	139	231	6·23	12·31
4. Do at 4½" depth	137	206	5·08	11·71

Grain, straw, P_2O_5 and N in the columns above are from an area of ¼ yard and total of 4 plots. F.y.m. at 3,000 lb. per acre was applied to all the plots. Phosphate was applied as superphosphate at ½ cwt. per acre.

TABLE XV

Experiments on the placement of phosphatic fertilizers at depths for ragi at Ramakrishna Krishi Shala

Treatment	1948 Summer Ragi grain in seers/acre	1948-49 Ragi grain in seers/acre	1949 Summer Ragi grain in seers/acre	1949 Summer Straw in lb. per acre
1. Superphosphate at ½ cwt. per acre applied at surface	620	315	520	5400
2. Superphosphate at ½ cwt. per acre applied at 3" depth	735	368	600	6050
3. Superphosphate at ½ cwt. per acre applied at 6" depth	635	388	730	7300

TABLE XVI

Experiment on the placement of phosphatic fertilizer for ragi at Babbur Farm

Treatment	1949				1950 Summer	
	Grain in seers per acre	Straw in lb. per acre	Grain in seers per acre	Straw in lb. per acre	Grain in lb. per acre	Straw in lb. per acre
	Application as Bonemeal		Superphosphate			
1. Phosphate at ½ cwt./acre applied at surface	340	1320	430	1315	1040	1278
2. Phosphate at ½ cwt./acre applied at 3″ depth	440	1260	540	1460	1171	1223
3. Phosphate at ½ cwt./acre applied at 6″ depth	510	1220	460	1270	1293	1433

Common treatments:—1949: 4 Cart-loads f.y.m. and a mixture of 100 lb. g.n.c. and 28 lb. ammonium sulphate per acre. 1950: 6 cart-loads f.y.m. and 2 cwt. of g.n.c. per acre.

(In the experiment in 1949, phosphate as bonemeal and also as superphosphate was tried. In 1950 only superphosphate was used.)

Small-scale plot trials have shown the superiority of placement of phosphate method to potatoes also, as the following Table shows :

TABLE XVII

Experiment on the placement of fertilizers for potatoes in plots in the pot-culture house

Treatments	Yield of potatoes in g. per sq. yard	Amount of plant food in the tubers from unit area	
		P_2O_5 in g.	N in g.
1. Control ..	585	0·71	1·04
2. N only ..	794	0·98	1·98
3. N + P ..	774	1·20	1·99
4. N + P + K at surface ..	859	1·32	2·08
5. N + P+ K at depth of 3″	991	1·53	2·18

Note.—N = 50 lb. of N per acre as a mixture of g.n.c. and Am_2SO_4 as 3 : 1; P = 25 lb. of P_2O_5 per acre as superphosphate; K = 25 lb. of K_2O as sulphate of potash. (The yield figures are an average of 4 replications.)

Field experiments on placement of phosphatic fertilizers for sugarcane conducted over a number of years at Babbur and the Hebbal Farms have demonstrated the effectiveness of placing superphosphates at depths before planting the setts compared to the usual method of applying this fertilizer in the planting furrows.

TABLE XVIII

Experiment on the placement of phosphatic fertilizer at depths for sugarcane at Hebbal Farm, 1949-50

	Treatment	Yield of cane in tons per acre
1.	2 cwt. of Super at 9" below surface	28·75
2.	Do at 12" do	26·15
3.	Do at 15" do	22·93
4.	Control	21·17

Common treatment:—10 Tons of compost per acre and 7 cwt. of ammonium sulphate and 1 ton of g.n.c., the last two applied in two doses.

The results with ragi crop in general indicate that an average depth of 3 to 6" is optimum for ragi, and that this placement can be effected by drilling the usual dosage of the fertilizer, say, ½ cwt. of superphosphate to the acre, through a single *sadde* attached to a country plough. In the case of irrigated or transplanted ragi, the seedlings can conveniently be planted in the furrows thus made. The same technique of placement can be followed for drill sown rainfed ragi also, the fertilizer being placed at the proper depth by drilling through a group of 5 to 6 *saddes* attached to a plough, and following this the seeds being drilled in the same set of parallel furrows through a second set of similar *saddes*. In practice it is found that germination of the seeds are in no way affected by contact with the fertilizers and even if the seeds should fall in close proximity to the fertilizer bands, their germination is not interfered with.

The above improved method of phosphate application can be adopted with advantage by our *ryots* without much difficulty and without involving any large variations in the present cultural practices.

DISEASES OF FODDER CROPS IN INDIA

II. Maize

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[*Maize forms one of the most important fodder crops grown widely in India. Its adaptability to almost all the tropical climates makes it an ideal crop. This crop belongs to the family GRAMINAE and is susceptible to the diseases common to the crops belonging to this family, like the smut, root rot, ear rot, etc. The development and anatomy of this plant play a prominent role in these diseases of the crop. It is estimated that nearly 10% to 12% of the total yield is affected by these diseases.*]

Maize, though primarily grown as a food crop, is of very great importance, as it is cultivated in some places of India as a fodder crop. This plant is cane-like, growing to a height of nearly 7 to 15'. The plant is monœcious with the female flower developing into an ear of corn. The various stages during the growth of the plant bears great importance in its susceptibility to the various diseases.

As it has been pointed out already most of these diseases owe their origin mostly to viruses, bacteria and fungi.

(*a*) *Diseases Caused by the Viruses*

Viruses damage crops of maize mostly in the temperate and the warmer climates of the world. The maladies are common to sugarcane, the sorghums and other allied grasses. Mostly these diseases are restricted to one group of plants. Virus diseases are supposed to be one of the most dreaded diseases as in most of the cases it is impossible to recover the infected plant. It has been proved that the viruses are transmitted by a variety of insect vectors like the aphids. In the case of maize it is the *Aphis maidis* that spreads the infection. One of the most recent hypotheses put forward is that the diseases in the maize are brought about by the insects that visit the sugarcane and transmit the disease from there.

The virus diseases of the corn are manifested as streak, stripe or of the mosaic variety.

Symptoms

The earliest symptom noticed in the case of the mosaic variety of the disease is the manifestation of dark and light green

mottling on the leaf. This type of mottling is also seen on the stalks. The commonest physiological appearance is the dwarfing of the plant. In some cases the ear production is also reduced. The other two diseases, namely, the stripe and the streak are identified by the occurrence of fine stripes and streaks on the leaves wherein mostly the mottled appearance is absent.

As stated before, these diseases are mostly spread by *Aphis maidis*. Some other aphids are also known to cause the infection such as *Peregrinus maidis*.

Control

The only known method of controlling these maladies are by the selection of resistant varieties of seeds. However, in this place, it needs admission that little has been known about the work done on the choice of resistant varieties of corn and their breeding.

(*b*) *Diseases Caused by Bacteria*

As in the case of the sorghums, the bacteria also play a very prominent role in causing manifold damages to the crops, by way of the diseases they cause. Bacterial blights have been known to occur widely in maize. The causative organisms are the same as the organisms that cause the disease in the sorghums.

(*i*) *Bacterial Blight*

Causative organism : *Bacterium stewartii* (E. F. Smith)
Phytomonas stewartii (E. F. Smith, Bergey, *et al.*)

Though this disease is more prevalent in the places where maize is grown for the sake of grain, it is well worth mentioning about the same due to the damages it causes both to the grain as well as the fodder.

Symptoms and Effects

This is a typical disease caused by bacteria which usually attack the vascular bundles of the plant in the stem, leaves and the inflorescence. The bacterial masses during the advanced stages break out of the bundles. Plants which do not get killed usually get stunted. One of the most common symptoms is the occurrence of lesions on the leaves. In the stem infection the exudate, which is typically yellow coloured, is a very conspicuous symptom.

Etiology

The most common source of infection is through the seed. It is also possible that the infection is introduced by insects that act as secondary hosts to this malady. These spread the disease through

the feeding injuries left by them on the stalks. The most common insect is the corn flea beetle (Elliot, 1941 : Rand and Cash, 1924). The bacteria after entering the plant multiply rapidly and fill the conductive tissues. From here it passes on to the other parts of the plant. A noteworthy point is that the diseased stalk tissues of the plant still contain the bacteria and these help as the source of infection in the next year. So much so, the infection and the infestation continue year after year in an enlarged proportion.

Control

The only control in this case lies in the choice of resistant varieties of seeds. Eradication of the secondary host might also help.

(ii) Cobb's Disease

Though this disease is primarily one of the diseases that attacks sugarcane, it merits our attention as it is capable of infecting maize also.

Causative organism : *Xanthomonas vasculorum* (Cobb.)
Phytomonas vasculorum (Cobb.) Bergey, *et al.*

Symptoms

In the early stages of development, this disease is mostly a leaf-disease. This disease, in this respect, bears a close resemblance to the bacterial wilt of maize. Occurrence of yellow to pale green stripes intermingled with red spots on the leaves herald the onset of the malady. Later all these stripes and spots fuse together forming more or less a continuous streak. Later the streaks turn red and thence necrosis of the leaf sets in. In advanced stages of the disease the plant becomes dwarfed and necrotic pockets develop in the stalks. Another symptom is the appearance of a honey-coloured exudate from the vascular tissues of the plant.

Etiology

Though the disease is more confined to sugarcane, Orian (1939) reported that maize and sorghum produce the symptoms when subjected to the infection by this bacterium. The infection spreads by means of the flies that visit the sugarcanes that are infected, and when the insects come and sit on a healthy maize plant, they transmit the bacteria.

Control is only by means of cultivating resistant species, elimination of the carriers, and if all these are not of much use, then a quarantine must be proclaimed over the infected area.

(c) Diseases Caused by Fungi

Coming to another important agent causing diseases in this plant, namely, the fungi, considerable attention has to be paid, for this plant

is attacked by a host of them. Some of the most common diseases are the Phythium root rot, Physoderma brown spot, Smut, Downy mildews, etc.

(*i*) *Physoderma Brown Spot*

Causative fungus : *Physoderma zea-maydis.*

Maize is amongst the only two known plants that are attacked by this fungus. Plants which are infected show lesions on the leaf and stalk tissues. To begin with the lesions are round to oblong, slightly water-soaked, light green and later on turning to a reddish brown colour. Later these reddish spots coalesce together forming brown blotches usually at the leaf-base of the leaf-blade. In most cases the stalks usually break off at the infection centres.

Symptoms

The earliest symptom observed is the occurrence of small yellow spots which later turn to a dark yellow and thence to a brown colour. Owing to the infection, the epidermis is liable to get bulged, then blistered and finally broken. At the broken spot a fine powdery mass is exudated. These are the resting spores of the parasite. In most of the cases it is the lower portions of the plant that get affected more than the other parts.

Etiology

This disease is caused by a fungus, namely, *Physoderma zea-maydis*. The brown spot lesions contain a large number of spores which are thick-walled and have a circular opening. These spores are blown off by the wind and fall to the ground getting mixed up with the soil. Under favourable conditions these spores germinate and liberate many zoospores which are about 3 to 4 microns in size and having a single cilium 4 to 5 times their size. These motile zoospores are the ones that produce the infection. On the surface of a new host they may either form a lot of thin-walled spores or send in rhizoid-like tubes which penetrate the surface of the host, entering the epidermal cell where it might branch repeatedly, thus subsequently infecting the adjoining cells also.

In some cases when the thick-walled spore falls on a corn leaf it may, instead of giving rise to zoospores, give rise to a lot of thin-walled spores, which enlarge forming a slipper-shaped structure which contains myriads of the zoospores.

This fungus is an intra-cellular fungus and attacks mostly the cortical cells. Another noteworthy point is that this fungus requires at least a minimum temperature of 23° C. for the resting spores to germinate. In addition to this it requires a thin film of water for

germination. This explains the fact as to why the plant attacks the leaf-sheath where these conditions occur naturally.

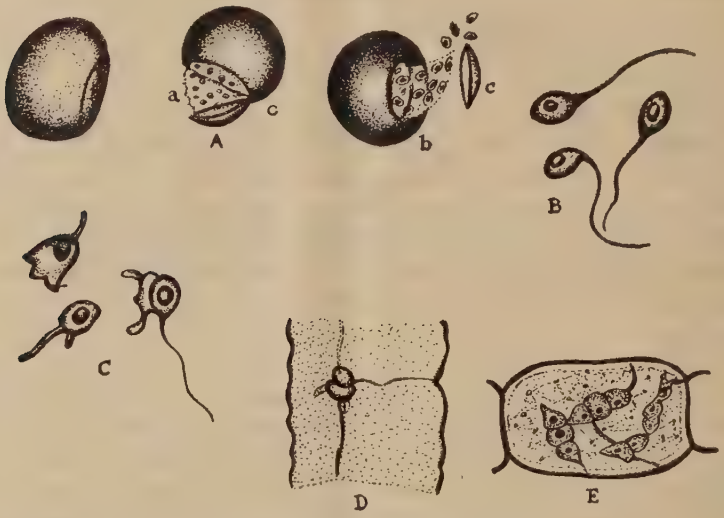

Fig. 1. *Physoderma zea-maydis* (showing stages in growth).

A. Sporangia showing escape of spores at *a* and *b* after opening of lid, *c* ; B. Zoospores ; C. Amœboid spores ; D. Infection of host cells by amœboid spore after coming to rest ; E. Turbinate cells of the pathogen within a host cell.

(Reproduced from " Elements of Plant Pathology," by Melhus and Kent.)

Control

As it is seen from the life-history of this parasite, the easiest methods of control are deep ploughing before sowing the seeds, rotation of crops and having general sanitary principles throughout the cultivation of this plant. As far as possible it is better to avoid manuring immediately before sowing the seeds.

(ii) Phythium Root Rot

This disease is common to almost all the plants throughout the world. In attacking the hosts, the parasite mostly attacks the rootlets. This disease is common to sugarcane, sorghums and other crops. But on maize it is not very destructive.

Causative fungus : *Phythium arrhenomanes* (Drechsler, 1936).

Symptoms and Effects

As it is known, the root lies in close proximity with the seedling tissue in the primary stages. So much so the pathogen is seen very near the seedling tissues in the form of light brown water-soaked lesions. Slowly the rot advances to the rootlets and root-hairs, and in some rare cases to the crown tissue above the soil. The main effect as

noted is that the root system gets completely depleted, from the seedling stage until maturity.

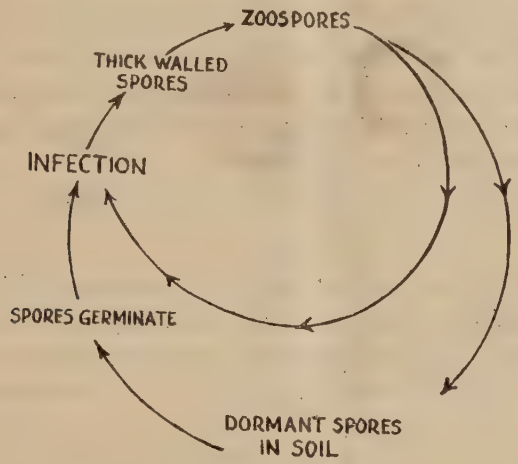

Fig. 2. Infection cycle of *Physoderma zea-maydis*

Etiology

The mycelium of the fungus is a non-septate, granular, highly branched hyaline hyphæ. The hyphæ penetrate the cells of the host and become either inter- or intra-cellular in the tissues. Under normal conditions the fungus produces two kinds of spores, namely, conidia and oospores. The conidia are formed as round to club-shaped structures on hyphæ. These drop off and on germination produce zoospores, which are biciliated. After some time the zoospore sends a germ tube that penetrates the host and thus starts the infection.

Oospores are formed as a result of the fusion between hyphæ in the fruiting or advanced stage. These are more common than zoospores. These are liberated only after the tissue of the stalk decay as they are enclosed within the tissues of the host. Under favourable conditions they germinate by the production of zoospores. These oospores remain dormant in the soil for a very long time.

Control

Cultural practices must be modified so as to avoid too much of moisture and temperature. Chemicals like formaldehyde and aluminium sulphate could also be used with advantage. Seed treatment may be followed to protect the germinating seed.

(iii) Downy Mildews

This disease is supposed to be caused by a species of Sclerospora, a description of which has already been published. The species that

attacks the maize has been identified to be *Sclerospora indica*. Control methods for the infection by this fungus are the same as those for infection by *Sclerospora graminicola* (which infects the sorghums).

(*iv*) *Helminthosporium Leaf-blight and Leaf-spots*

This particular disease is caused by three different species of fungus which are distributed geographically. But the most important disease is caused by one of the fungus.

Causative fungus : *Helminthosporium turcicum.*

Symptoms

The earliest symptom observed is the occurrence of lesions usually oblong to elliptical on the leaf-blades extending upto the leaf-sheath. These are usually to begin with, brown in colour later on turning black, and thence to straw colour.

Etiology

On the leaf-sheath the fungus produces number of conidia. The conidiophores emerge through the stomata. They are about 7-9 by about 150-250 microns in size, and are septate. The conidia that are dropped off are of various sizes and shapes. The remains of the old crops in the field helps the spreading of the infection.

Control

Cultivating varieties of maize that are resistant to the disease is one way of control. As in other diseases rotation of crops should go a long way in effecting a control for this disease.

(*v*) *Smut*

Corn smut is one of the most common as well as the most widespread diseases in the crop. The smut does not usually attack the grain, compared to the other smuts of cereals. Once the parasite gets introduced into the crop, it is very difficult to eradicate the same. Due to the heavy damage it causes to the fodder it merits our very serious attention.

Causative fungus : *Ustilago zeæ.*

Symptoms and Effects

The symptoms of the smut may occur on any part of the plant above the ground, from the tassel to the ground line. The common symptoms include chlorophyll changes, formation of anthocyanin pigment, and in advanced stages necrosis of the affected parts. The earliest symptoms that are manifested on the onset of the disease is the yellowing of leaves, due to the reduction of chlorophyll in the affected areas. Galls may not occur in the case of the leaf-smut, but may expose itself as splotches of colour on the leaves. These splotches may vary

from a tiny spot to an elongated line in size. Mostly it is usual to overlook these symptoms.

If a microscopic examination of the affected leaf is made, the section passing through the discoloured patch, one can see the precipitated anthocyanin in the epidermal cells wherein it was in solution in the cell-sap. The most common symptom is the formation of galls which may vary in size from a tiny pustule to big ones several inches in diameter. This is entirely due to the hypertrophy of the affected tissues. They are at first whitish in colour, later on turning to black. The colouration is due to the membranous covering of the infected tissues. On turning black the membrane breaks open liberating the fine, powdery, black spores.

Galls may be formed at any place where meristematic tissues occur. The most common places are the midrib and surrounding places, nodal buds, axillary buds, junction of leaf-sheath and leaf-base, flowers of the ear, etc. When the pressure of the galls are not enough to break open the leaf-sheath, it encircles the stalk forming a ring which is not visible, until the leaves are stripped out.

Etiology

The maize smut is caused by a fungus known as *Ustilago zeæ*. The mycelium of the parasite is many-celled, highly branched, binucleate and inter-cellular. The chlamydospores which are liberated by the breaking of the tissue on the galls germinate on a new substratum and form a basidium or promycelium. The basidium in its turn produces sporidia laterally and terminally. These sporidia bring about the infection. The fungus has been known to exhibit heterothallism in which case the reduction division occurs during the time when the chlamydospore germinates and forms a promycelium.

The infection can be said to be brought about as follows. In the growing season the chlamydospores and the sporidia are blown about by the wind and they come to rest on a very young growing point of an uninfected maize plant. Here it germinates and produces the sporidia which bring about the infection. In this plant the susceptibility to the smut ceases when the plant grows to a height of 18″ for, by this time the formation of meristematic tissue ceases. If the formation of the meristematic tissue is stimulated (by an injury) then the plant might become susceptible again.

If the hyphæ of two adjoining cells fuse together the contents of one cell passes on to the other. This binucleate cell gives rise to a new hyphæ known as the fusion hyphæ. Probably this is the hyphæ that induces the formation of galls and chlamydospores. It is also possible that the uninucleate cells do not give rise to the chlamydospores at all. The hyphæ start segmenting as the host approaches its

maturity and the segments get rounded up inside the galls. These form the chlamydospores and are later on liberated by the rupture of the covering tissue and they start the infection cycle again.

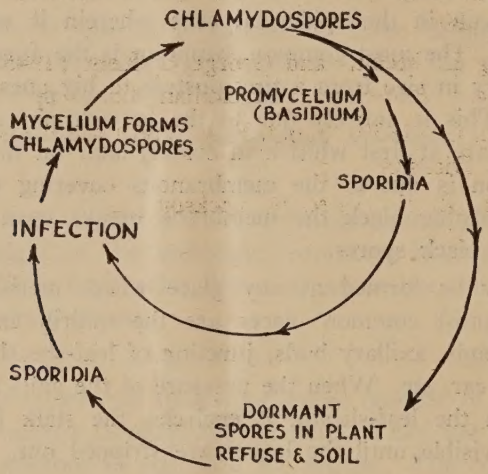

Fig. 3. Infection cycle of *Ustilago zeæ*

Control

In case where the eradication of infected crops is possible it is better to do so. Smut-resistant hybrids also offer a possible way of prevention of this disease.

(*vi*) *Maize Rust*

This disease is caused by another fungus, namely, *Puccinia sorghii*. This fungus also attacks many other plants. A study of this fungus has already appeared in another communication. Methods of control are the same as for the infection by *Puccinia sorghii* for sorghum.

Laboratory scale studies have been carried out by many scientists in the world, and they have succeeded in producing seeds that are resistant to some of these diseases. It is therefore upto the scientist and the farmer to establish closer and better understanding so that the farmer can give us good crops with the seeds the scientist is able to develop and give.

References

1. Bawden, F. C. (1943). *Plant Viruses and Virus Diseases.* (Chronica Botanica Company). 2nd Edition, p. 62.
2. Butler, E. J. (1913). Cited by Dickson.
3. Charles E. Skinner, *et al.* (1947), *Henrici's Yeasts, Molds and Actinomycetes.* (John Wiley & Sons Inc.). 2nd Edition, p. 114.

4. Drechsler, C. (1936). Cited by Dickson.
5. Elliot, C. (1941-43). Cited by Dickson.
6. James G. Dickson (1947), *Diseases of Field Crops* (McGraw-Hill Book Co. Inc.). 1st Edition, pp. 65-71, 73, 85, 89.
7. Irving E. Melhus and George C. Kent (1948). *Elements of Plant Pathology* (Macmillan Co.), pp. 143-47, 343-50.
8. Orian, G. (1939), Rand, F. V., and Cash, L. C. (1924). Cited by Dickson.
9. Smith, E. F. Cited by Dickson.

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